

APPLICATION
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TITLE: BATTERIES

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Batteries

TECHNICAL FIELD

This invention relates to batteries.

BACKGROUND

Digital cameras and other electronic devices (for example, cell phones, MP3 players, and
5 personal digital assistants (PDA's) such as BlackBerries[®]) operate on batteries, such as secondary
(i.e., rechargeable) nickel metal hydride batteries or secondary lithium ion batteries. One type of
battery that has been used in digital cameras is the Pentax D-L12, a 3.7 V secondary, prismatic
lithium ion battery available from Panasonic and depicted in FIGS. 1 and 2.

Referring to FIG. 1, battery 10 has a length "L" of about 53.0 mm, a width "W" of about
10 35.2 mm, and a thickness "T" of about 7.0 mm. In this application, the type of prismatic cell
illustrated in FIGS. 1 and 2 generally will be referred to as "Battery A". Other specific examples
of Battery A-type batteries include the Pentax D-L12B, the Gold Peak VFL001, the Panasonic
VW-VBA10, the Mugen Power HLI-NP60, and the Fujifilm NP60.

Referring now to FIG. 2, a surface 12 of battery 10 has three electrical contacts 14, 16,
15 and 18 positioned in a side-by-side arrangement. Contact 14 is positive, and contact 18 is
negative. Contact 16, located between, and at an equal distance from, contacts 14 and 18, is a
thermistor. The thermistor is a thermally sensitive resistor that regulates recharging. As battery
10 is charged, the temperature of the battery increases, thereby causing the thermistor to increase
its resistance to current flow. As a result, the charge current through battery 10 decreases. If
20 battery 10 becomes too hot, then the thermistor shuts off the charge. When battery 10 is inserted
into a digital camera or charger, contacts 14, 16, and 18 touch corresponding contacts in the
camera or charger.

Another example of a secondary, prismatic lithium ion battery is the Casio NP20. The
type of battery exemplified by the Casio NP20 will generally be referred to as "Battery B".
25 Battery B has three electrical contacts (a positive contact, a thermistor, and a negative contact),
and its dimensions are 50mm x 33mm x 4.5mm.

Another example of a secondary, prismatic lithium ion battery is the Olympus LI-10B.
The type of battery exemplified by the Olympus LI-10B will generally be referred to as "Battery

C". Battery C has three electrical contacts (a positive contact, a thermistor, and a negative contact), and its dimensions are 46mm x 32mm x 9.7mm.

Another example of a secondary, prismatic lithium ion battery is the Motorola SNN5717C. The type of battery exemplified by the Motorola SNN5717C will generally be referred to as "Battery D". Battery D has four electrical contacts (a positive contact, a thermistor, a resistor, and a negative contact), and its dimensions are 58mm x 35.6mm x 7.0mm. A resistor can help an electronic device (e.g., a digital camera, a charger) to identify the chemistry of a battery.

Another example of a secondary, prismatic lithium ion battery is the Motorola SNN5705B. The type of battery exemplified by the Motorola SNN5705B will generally be referred to as "Battery E". Battery E has four electrical contacts (a positive contact, a thermistor, a resistor, and a negative contact), and its dimensions are 58mm x 35.6mm x 4.6mm.

Another example of a secondary, prismatic lithium ion battery is the Nokia BL-5C. The type of battery exemplified by the Nokia BL-5C will generally be referred to as "Battery F".

Battery F has four electrical contacts (a positive contact, a thermistor, a resistor, and a negative contact), and its dimensions are 53mm x 34mm x 5.7mm.

Another example of a secondary, prismatic lithium ion battery is the BlackBerry® BAT-03087-002. The type of battery exemplified by the BlackBerry® BAT-03087-002 will generally be referred to as "Battery G". Battery G has four electrical contacts (a positive contact, a thermistor, a resistor, and a negative contact), and its dimensions are 50.5mm x 38mm x 7.1mm.

SUMMARY

The invention generally relates to a primary battery (e.g., a lithium battery) for use in an electronic device (e.g., a digital camera, a cell phone, an MP3 player, or a personal digital assistant (PDA) such as a BlackBerry®).

In one aspect, the primary battery has approximately the same dimensions as Battery A, but has at least one positive or negative contact that is positioned in a location different from the location of the corresponding positive or negative contact in Battery A.

In some embodiments, the primary battery includes recess(es) that correspond to the positions of the positive contact and/or negative contact in Battery A. The positive and/or negative contacts for which there are recesses in the primary battery have been repositioned in

the primary battery relative to Battery A. The primary battery preferably does not include a thermistor that has an independent contact (i.e., separate from the positive and negative contacts) on the battery housing. In certain embodiments, the primary battery may include a recess corresponding to the position of the thermistor in Battery A. A primary battery that includes the recess(es) can be used in digital cameras with contacts that allow the camera to operate with either Battery A or primary batteries. However, if the primary battery is accidentally placed in a charger intended for use with Battery A, it will not recharge because it does not have a set of contacts that correspond to the contacts in the charger. This is advantageous to a user of the primary battery because the user does not have to be concerned about, for example, overheating of the primary battery when it is accidentally placed in the charger. The primary battery can be designed to fit, for example, into a small and/or thin-profile digital camera. Another advantage is that the primary battery does not require the user to carry and/or travel with burdensome accessories such as AC power cords and chargers.

In another aspect, the primary battery (e.g., a lithium battery) has approximately the same dimensions as Battery B, C, D, E, F, or G. The primary battery can be different from Battery B, C, D, E, F, or G in one or more of the ways discussed above with respect to the first aspect of the invention. For example, the primary battery can have at least one positive or negative contact that is positioned in a location different from the location of the corresponding positive or negative contact in Battery B, C, D, E, F, or G.

In another aspect, the primary battery includes a housing having a thickness between about 2 mm and about 15 mm, a width between about 10 mm and about 50 mm, and a length between about 20 mm and about 60 mm. The primary battery also includes a positive electrical contact and a negative electrical contact located on a surface of the housing. Within the housing are an anode, a cathode, and an electrolyte. The battery does not include a thermistor that has an independent contact on the battery housing.

In another aspect, the primary battery includes a housing having a thickness between about 2 mm and about 15 mm, a width between about 10 mm and about 50 mm, and a length between about 20 mm and about 60 mm. Within the housing are an anode, a cathode, and an electrolyte. The primary battery also includes a positive electrical contact and a negative electrical contact located on a surface of the housing. The positive electrical contact and the negative electrical contact each occupy a contact space of about the same size, and are separated

by a space that is at least big enough to provide adequate insulation between the contacts (e.g., to prevent an electrical short between the contacts). In some embodiments, the positive electrical contact and the negative electrical contact are separated by a space that is approximately equal in size to the contact space. In certain embodiments, the positive electrical contact and the negative electrical contact are separated by a space that is at least about 1.5 times the size of the contact space (e.g., at least about two times the size of the contact space, at least about 2.5 times the size of the contact space).

In some embodiments, the above batteries do not include a thermistor that has an independent contact on the battery housing.

In another aspect, the primary battery includes a prismatic housing having a thickness between about 2 mm and about 15 mm, a width between about 10 mm and about 50 mm, and a length between about 20 mm and about 60 mm. Within the housing are an anode, a cathode, and an electrolyte. The primary battery also includes a positive electrical contact and a negative electrical contact located on a surface on the housing, at opposite ends of the surface.

In another aspect, the primary battery includes a housing (e.g., having a thickness between about 2 mm and about 15 mm, a width between about 10 mm and about 50 mm, and a length between about 20 mm and about 60 mm). Within the housing are an anode, a cathode, and an electrolyte. A positive electrical contact and a negative electrical contact are on a surface of the housing. The negative contact also functions as a resistor.

In another aspect, the primary battery is a 3 Volt battery that includes a prismatic housing having a thickness between about 2 mm and about 15 mm, a width between about 10 mm and about 50 mm, and a length between about 20 mm and about 60 mm. Within the housing are an anode, a cathode, and an electrolyte. A positive electrical contact and a negative electrical contact on a surface on the housing.

In another aspect, the invention features a digital camera that can be used with one or more of the above batteries. In some embodiments, the camera has a housing with a surface that includes three electrical contacts: a positive electrical contact, a negative electrical contact, and a positive or negative electrical contact.

As used herein, the term “primary battery” refers to a battery that is designed to be discharged, e.g., to exhaustion, only once, and then discarded. Primary batteries are described, for example, in David Linden, Handbook of Batteries (McGraw-Hill, 2d ed. 1995).

For the purposes of this application, a “prismatic cell” has at least four generally flat sides, and has one dimension (e.g., thickness) that is substantially smaller than two other dimensions (e.g., length and width). As an example, a prismatic cell can have a thickness of between about 2 mm and about 15 mm (e.g., between about 4 mm and about 10 mm), a width of
 5 between about 10 mm and about 50 mm (e.g., between about 20 mm and about 40 mm), and a length of between about 20 mm and about 60 mm (e.g., between about 30 mm and about 40 mm).

Other features and advantages are in the description, drawings, and claims.

DESCRIPTION OF DRAWINGS

10 FIG. 1 is a perspective view of a battery.

FIG. 2 is a top view of the battery of FIG. 1.

FIG. 3 is a perspective view of a battery.

FIG. 4 is a top view of the battery of FIG. 3.

FIG. 5 is a cross-sectional view of the cell of the battery of FIG. 3.

15 FIG. 6 is a perspective view of the battery of FIG. 3.

FIG. 7A is a perspective view of a component of the battery of FIG. 3.

FIGS. 7B, 7C, 7D, 7E, 7F, 7G, 7H, 7I, and 7J illustrate a method of making the battery of FIG. 3.

FIG. 8 is a top view of a battery.

DETAILED DESCRIPTION

20 Referring to FIG. 3, a primary lithium battery 100 includes a housing 102 having a surface 104. Surface 104 includes two ends, 105 and 107, that define the width of battery 100. Battery 100 has the same general shape and dimensions as Battery A. Thus, battery 100 can fit into a space in a digital camera that is also capable of fitting Battery A. However, battery 100 is
 25 a 3 V battery, and thus has a different voltage from Battery A. Housing 102 can be made of a metal or metal alloy (e.g., nickel, nickel plated steel, stainless steel, aluminum, an alloy containing aluminum) or a plastic (e.g., a polyamide, polyvinyl chloride, polypropylene, polysulfone, acrylonitrile butadiene styrene (ABS), polystyrene).

Referring now to FIG. 4, surface 104 of battery 100 includes two electrical contacts: a
 30 positive contact 106 and a negative contact 108. Between electrical contacts 106 and 108 are

two recesses, 110 and 112. Positive contact 106 is located approximately at end 105 of surface 104, while negative contact 108 is located approximately at end 107 of surface 104. Generally, recesses 110 and 112 are made of non-conducting materials. Recesses 110 and 112 can be made of, for example, a plastic (e.g., a polyamide, polyvinyl chloride, polypropylene, polysulfone, acrylonitrile butadiene styrene (ABS), polystyrene). In some cases, recesses 110 and 112 are made of the same material as housing 102, while in other cases recesses 110 and 112 and housing 102 are made of different materials. If primary battery 100 were accidentally placed into a charger with contacts suitable for recharging Battery A, battery 100 would not be recharged because at least one of its electrical contacts would not touch a corresponding contact in the charger.

FIG. 5 shows a cell 149 that is contained within battery 100. Cell 149 includes an anode 150, a cathode 154, a separator 158, and an electrolyte 162.

The anode active material in cell 149 can be, for example, lithium or a lithium-containing material (e.g., an alloy that contains lithium and aluminum, calcium, sodium, and/or magnesium).

The cathode active material can be, for example, a metal oxide such as manganese dioxide (MnO_2). In some cases, the cathode active material can be electrolytic manganese dioxide (EMD). Other cathode active materials are described, for example, in co-pending and commonly assigned U.S. Published Patent Application No. US 2003/0124421 A1, published on July 3, 2003 and entitled "Non-Aqueous Electrochemical Cells", which is herein incorporated by reference in its entirety.

The cathode can include other components, such as a binder (e.g., PTFE) and/or a conductive material (e.g., carbon). Binders are described, for example, in co-pending and commonly assigned U.S. Patent Application Serial No. 10/290,832, filed on November 8, 2002 and entitled "Flexible Cathodes", which is herein incorporated by reference in its entirety.

Separator 158 can be formed of any of the standard separator materials used in nonaqueous electrochemical cells. For example, the separator can be formed of polypropylene (e.g., nonwoven polypropylene or microporous polypropylene), polyethylene, and/or a polysulfone. Separators are further described, for example, in U.S. Patent No. 5,176,968, which is hereby incorporated by reference in its entirety.

Electrolyte 162 can be in liquid, solid or gel (polymer) form. The electrolyte can contain an organic solvent (e.g., propylene carbonate) or an inorganic solvent (e.g., SO₂, SOCl₂). In some embodiments, the electrolyte can include an additive or additives. For example, the electrolyte can contain a lithium salt such as lithium trifluoromethanesulfonate (LiTFS) or lithium trifluoromethanesulfonimide (LiTFSI), or a combination thereof. Additional lithium salts that can be included are listed in U.S. Patent No. 5,595,841, which is hereby incorporated by reference in its entirety. Electrolytes are described in previously incorporated U.S. Published Patent Application No. US 2003/0124421 A1.

Referring to FIGS. 6 and 7A, battery 100 preferably includes an assembly 179 with a positive temperature coefficient resistor (PTC) 180 that is connected to leads 182 and 184. Lead 182 serves as negative contact 108, and lead 184, which is welded to battery housing 102, serves as a conductor. PTC 180 can prevent battery 100 from overheating if, for example, a user shorts battery 100. PTC 180 is a thermally sensitive resistor. As the temperature of battery 100 increases, PTC 180 slightly increases the resistance to current flow within battery 100. If a predetermined temperature is reached in battery 100, then PTC 180 substantially increases its resistance to current flow, thereby effectively shutting off the current flow within battery 100 and preventing battery 100 from overheating. After the source of the short has been removed, PTC 180 restores the standard level of resistance within battery 100.

FIGS. 7B-7I show the incorporation of assembly 179 into battery 100 during the manufacture of battery 100. In FIG. 7B, lead 182 is bent to an angle of approximately 90 degrees, and in FIG. 7C, assembly 179 is incorporated into a spacer 186. Referring now to FIG. 7D (in which assembly 179 is rotated approximately 180 degrees relative to its position in FIG. 7C), lead 182 is then folded down in the direction indicated by arrow A. FIG. 7E shows the opposite side of assembly 179 at this point. In FIG. 7F, assembly 179 is then mounted onto housing 102 (e.g., by gluing) in the direction of arrows B, to produce the cell 190 shown in FIG. 7G. Thereafter, and referring now to FIG. 7H (in which cell 190 is rotated approximately 180 degrees relative to its position in FIG. 7G), positive contact 106 is attached (e.g., welded) to cell 190 in the direction of arrow C. Next, as shown in FIG. 7I, positive contact 106 is folded down (and PTC 180 is welded to housing 102). Referring to FIG. 7J, a spacer cover 194 is then placed onto cell 190 in the direction of arrow D.

Although one arrangement of contacts on a primary battery is shown in FIGS. 3 and 4, different arrangements are possible. For example, and referring now to FIG. 8, a battery 200 with the same general shape and dimensions as Battery A and battery 100 includes a surface 202 with a negative electrical contact 204 adjacent to a positive electrical contact 206. Surface 202 also includes two recesses, 208 and 210. As with battery 100 of FIGS. 3 and 4, if primary battery 200 were inadvertently placed into a charger for Battery A, battery 200 would not be recharged, since at least one of its electrical contacts would not touch a corresponding contact in the charger.

In some embodiments, and as described above with reference to Batteries D, E, F, and G, the primary battery can correspond to a secondary battery that includes four electrical contacts: a positive contact, a negative contact, a thermistor, and a resistor.

While primary lithium batteries have been described above, other types of battery chemistries can be used. As an example, the primary battery can be an alkaline battery. Alkaline batteries, including suitable anode and cathode materials, are described in, for example, co-pending and commonly assigned U.S. Patent Application Serial No. 09/658,042, filed on September 7, 2000 and entitled "Battery Cathode", and U.S. Published Patent Application No. US 2002/0172867 A1, published on November 21, 2002 and entitled "Battery Cathode", both of which are herein incorporated by reference in their entirety. Alkaline batteries also are described in U.S. Patent No. 6,509,117, which is hereby incorporated by reference in its entirety. In some cases, the primary battery is a zinc-air battery. Zinc-air batteries are described in, for example, David Linden, Handbook of Batteries (McGraw-Hill, 2d ed. 1995).

Other embodiments are within the claims.